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AUGUST 16 1920

SERIAL NO. 209

Cook County, Illinois

THE MENTOR

THE STORY OF RUBBER

By
PETER PHILIP PINTO

DEPARTMENT OF
SCIENCE

VOLUME 8
NUMBER 13

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RUBBER! RUBBER!

Not long ago in conversation with a friend the talk drifted to the question of human observation. Said he, "Of all the traits we possess, the one showing the greatest deficiency is our lack of common everyday perception. We notice things without recording a definite impression. For example," he continued, "how many steps are there leading up from the pavement to the ground floor of the club where you lunch each day?"

I replied that I might guess, but I couldn't be sure.

"There you are," said he. "You have entered that building several thousand times and you don't know."

This same lack of close attention runs through the whole of our lives. We have come to accept things as they are, seldom questioning the why and wherefore of our most intimate associations. I saw a statement the other day that rubber was the *fifth necessity of life*, and as I picked up a rubber band to snap it round a package of letters I wondered if that declaration could possibly be true. Later, on the street, as the thousands of automobiles and motor trucks rushed along, I began to picture a world without rubber and many of the doubts concerning the truth of the assertion were swept out of my mind.

"If rubber is so important," thought I, "just where do we as a nation line up in the world's business in this essential material?"

FLOYD W. PARSONS, in *The Saturday Evening Post.*

(MR. PARSONS' QUESTION IS ANSWERED IN THIS MENTOR.)

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PROVISO TOWNSHIP HIGH SCHOOL
Cook County, Illinois

THE MENTOR · DEPARTMENT OF SCIENCE
SERIAL NUMBER 209

The STORY OF RUBBER

By PETER PHILIP PINTO, Editor of *The Rubber Age*

MENTOR GRAVURES

CHARLES GOODYEAR

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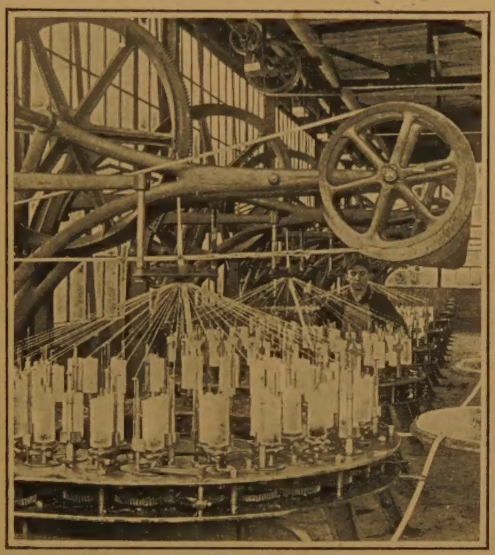
SNAKY-ROOTED RUBBER TREE

•

SCENE IN RUBBER FACTORY



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BRAIDING COTTON COVERING AROUND STEAM HOSE

MENTOR GRAVURES

MAKING RUBBER FOOTWEAR

•

RUBBER HOSE MANUFACTURE

•

MAKING RUBBER TIRES

HOW many people realize that a game of "catch" played by half naked Indian children about four centuries ago was the starting point of one of the greatest industries known to civilization—one that has changed the methods of existence of the entire civilized world? Columbus, on his voyage to South America in 1498 saw native children of Hayti playing with balls that bounced amazingly—greatly different from the balls of rags which the children of Spain used at that time. Those bouncing balls were made of rubber, which was the gum or hardened juice of a tree, so Columbus learned. As a matter of curiosity, samples were taken back to Spain by the discoverer, but, as he brought back no gold, he was thrown into jail and the little black balls were soon forgotten. Little did he or anyone else realize that the material out of which they were made could be turned into more gold than the King and Queen of Spain ever dreamed of.

It was not until the next century, in 1536, that a Portuguese missionary, in exploring the Amazon region in Brazil, discovered further traces

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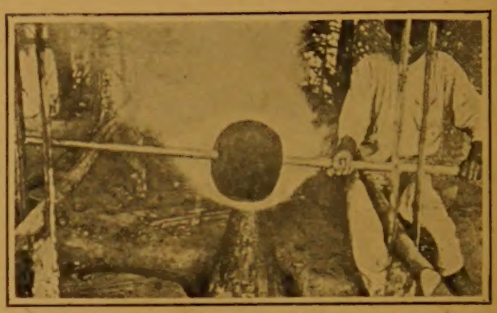
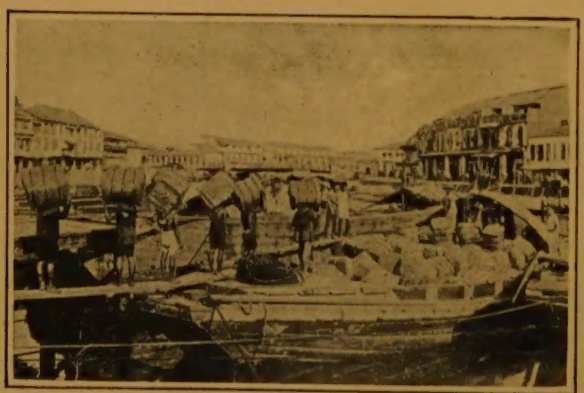


METHOD OF SMOKING RUBBER

of the same gum. This time, however, it was noticed that the natives were making crude shoes of this coagulated juice, and using them to keep their feet from getting wet. The natives had already discovered the waterproofing qualities of rubber, or, as it soon came to be known, *caoutchouc* (from the native name, *cahuchu*, meaning weeping wood).

The missionaries soon learned to make rubber shoes and waterproof cloth, and thus began the use of rubber as a waterproofing material. Gradually samples of this material found their way into Europe. However, it was not until 1731 that any concentrated effort was made to learn more of this marvelous substance, which had already begun to interest scientists. It was in that year that the Paris Academy of Science sent explorers to investigate the sources and uses of the gum. The report made several years later by Monsieur LaCondamine gave the name of *Hevé* (now known as *Hevea*, a prominent member of the rubber producing trees) to the tree from which the gum was obtained. LaCondamine reported that "the liquor which flows from this tree hardens gradually and blackens in the air." Natives were found blackening rubber boots in smoke, causing it to resemble leather, and also making unbreakable bottles to hold liquids. In a short time Lisbon began to import a number of these rubber articles, but they were still considered a curiosity for another generation. It remained for the famous English scientist, Priestly, to give impetus to the rubber industry, when, in 1770, he discovered that this gum would rub out pencil marks. From this came the name *rubber*. The manufacture of rubbers, or erasers, was then begun in England, and artists and draughtsmen were glad to pay the price, seventy-five cents, for this article which helped them so much in their work.



COOLIES CARRYING RUBBER TO LIGHTER
Each bale weighs from 200 to 250 pounds. Scene taken at Singapore

The beginning of the nineteenth century ushered in the manufacture of rubber articles in Brazil. Some of the shoes, bottles and tobacco pouches found their way to North America, and they were eagerly sought by the New England settlers.

It was not until 1823, however, that a man named Charles Mackintosh put rubber to a practical use in making waterproof clothing. He obtained a patent for rendering fabrics

waterproof by uniting them with a solution of rubber in coal naptha. These clothes soon became known as "mackintoshes"—a name still applied to a certain type of raincoat. It was discovered, however, that extremes of heat and cold destroyed the usefulness of these coats; in winter they got hard and stiff and in summer became soft and sticky. It was this difficulty that checked the popularity of the rubber raincoat.

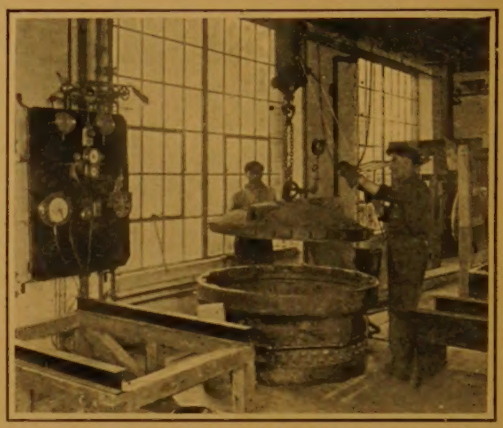
At this point in the development of rubber for commercial use we learn that, on account of the difficulties that had been met, and that no one had been able to surmount, the rubber industry, with all its promise, was about to disappear as a factor in the nation's progress. A few unimportant articles continued to be manufactured, but only such as were not greatly affected by changes in heat. Early manufacturers certainly had their troubles. Then, out of a clear sky, came a solution of the problem—and, as was the case in many other famous discoveries, it was brought about by accident.

The discovery of *vulcanization* very quickly gave rubber an important role in the affairs of civilization. It was an American, Charles Goodyear, who made this discovery,—one of the most important of modern times, ranking with that of electricity, the invention of printing, gunpowder, airplanes, balloons, the wireless telegraph and telephone and the gasolene engine.

In Woburn, Massachusetts, in 1844, Goodyear found that rubber mixed with sulphur, and subjected to a certain degree of heat, would become pliable, and was *not subject to changes in temperature.* This was astonishing, since rubber gum, of itself, would melt at a comparatively low temperature. Goodyear had worked for years on this problem until he was reduced to abject poverty. He had borrowed from all his friends and, occasionally, had been in jail for debt. He dressed in rubber clothes to test their durability and was readily recognized by the description that someone gave of him: "If you see a man with a rubber coat on, rubber shoes, rubber cap, and, in his pocket, a rubber purse with not a cent in it—that is Goodyear."

RECEIVING AND SORTING RUBBER AT A SINGAPORE WAREHOUSE

WASHED RUBBER HUNG TO DRY



CLOSING A VERTICAL VULCANIZING HEATER
This type is used for curing tires and usually extends 20 to 30 feet down into the floors below

To this man, almost on the point of ruination, belongs the honor of the discovery of vulcanization. We are told that he had been "trying to incorporate some sort of dryer in rubber that would permanently prevent rubber clothing from becoming sticky . . . . One of his hundreds of experiments was a combination of rubber, sulphur and white lead, dissolved in spirits of turpentine. This was spread with a broad bladed knife on several pieces of cloth. To hasten the evaporation of the solvent he hung the pieces near a stove. One, through accident, rested against the hot iron and turned black, while the others were of a grayish white color. Disgusted at his carelessness Goodyear took the black sample and was about to throw it away when its curious texture halted him. He examined it carefully and recognized what he termed the 'change,' and which Brockedon later happily termed 'vulcanization.'"

Thus Goodyear found in 1844, after five years of experimenting, that the dreaded heat was the element that he needed. The application of heat to a mixture of rubber and sulphur and its resultant action is known as vulcanization, after Vulcan, the Greek God of Fire. Just as the baker mixes his dough, and then bakes it to make bread, so the rubber manufacturer mixes rubber and sulphur and other chemicals, to give certain properties to the rubber, and vulcanizes or bakes it.

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VARIOUS FORMS OF CRUDE RUBBER
Left lower—Plantation Crêpe. Right upper—Washed wild rubber. Right lower—a rubber "biscuit" cut in half to show various layers

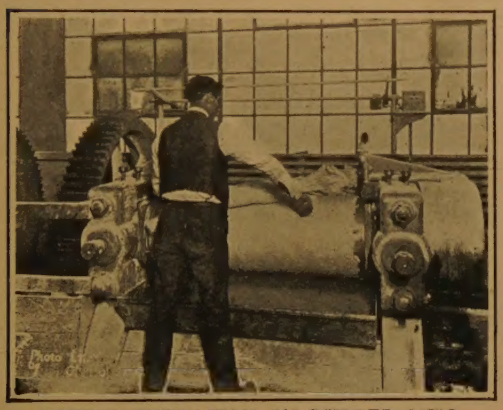
This was the first important discovery since the actual finding of rubber by the Spaniards. Rubber, once classed as practically useless—a failure, a laughing stock—was soon respected, and rubber articles were eagerly sought. Soon it entered varied fields little thought of at first, until, today, it is used in so many ways that we should, indeed, feel that we lived in a strange world if we were deprived of it. Rubber is now ranked as the most important and valuable vegetable product known.

Fortunes have been made in the rubber industry, which has grown

tremendously in the last generation. Akron, the rubber metropolis of the world—where more than 75% of the tires and 41% of all rubber goods in this country are manufactured—is now a city of 208,000, whereas, ten years ago, it had a population of about 69,000. Here is manufactured every conceivable kind of rubber article, and here are assembled the largest number of companies, devoted to rubber manufacturing, in the world. The industry has expanded until we now find rubber factories scattered all over the United States—a group is located in Trenton, New Jersey; another, largely devoted to boots and shoes, in Boston; a sizable plant is located in Los Angeles, and there are numerous others in smaller centers.

Sources of Supply

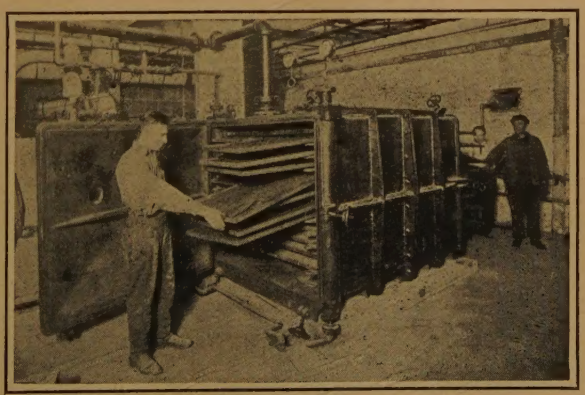
The trees, vines and shrubs from which rubber is obtained may be numbered by the hundred, spread over a restricted portion of the world's surface. This belt includes part of Mexico, Central America, South America north of Argentina, Africa from Cape Colony to Sahara, Oceanica, Java Sumatra, Borneo, India, Malay States and the Philippines. It will be noticed that this forms a region extending around the world in a territory approximately 600 to 800 miles on either side of the equator.



MIXING OPERATION ON RUBBER MILL

For a long time rubber had been gathered only in the forests of Brazil, and Africa. Here the trees grew wild, and, till 1898, the whole of our supply was obtained from this source. The idea of planting rubber trees in plantations, just as fruit trees are cultivated, was ridiculed as a commercial impossibility. Experiments and transplanting, however, were made, and it was found feasible to grow the wild trees of the Amazon in other tropical countries. Today cultivated rubber greatly exceeds the wild product, with a consequent decrease in cost and increase in purity.

For a time all rubber was called "Para rubber," taking its name from the town of Para in Brazil from which all the rubber was shipped. In other parts of the world various kinds of trees, shrubs and vines were found to yield

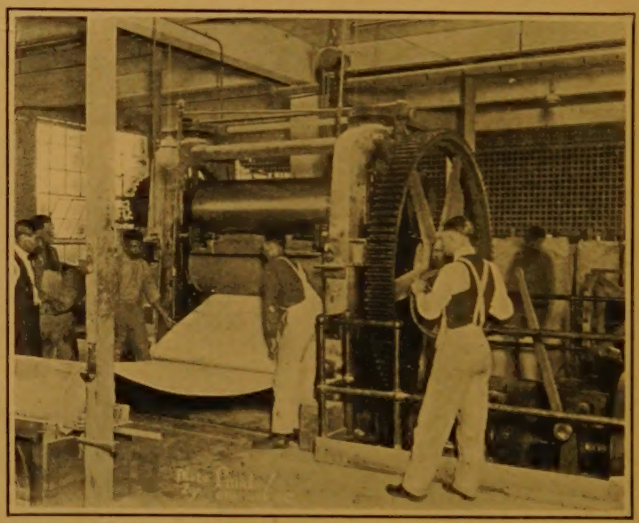


REMOVING WASHED AND DRIED RUBBER FROM A VACUUM DRYER

rubber, but the quality of the product did not equal that found in the jungles of Brazil. In 1876 seeds from the Hevea tree, mentioned in La-Condamine's report, were planted in Kew gardens in London, and the seedlings were introduced into Ceylon and later into Malay States, India, Sumatra, Java and Borneo.

A small production of four tons of plantation rubber was obtained in 1900 from these trees, and, in 1907, it had risen to about 1,000 tons. Today the production of wild rubber continues at the rate of about 40,000 tons yearly, while that of cultivated or plantation rubber is about *eight times as much* and is still on the increase.

The classification of rubber depends on whether it is of the wild or plantation variety, and on the location in which it grows. Wild rubber is found mostly in Africa and South America, and to a lesser extent in Java, Sumatra, Borneo and Mexico. The African rubbers appear under various names, as Soudans, Cameroons, Congos, Gold Coast Lumps, Kassais, Rambong, et cetera. The South American rubbers are known as Paras, Castillons, Manicoba, Manihot. Plantation rubber comes mostly from Hevea trees, as has been explained, only a small part of the total production being obtained from trees of other species, such as Castilloa and Ficus. These grades of rubber are obtained in Ceylon, Sumatra, Java, Borneo, Indo-China, India and Malay Peninsula. From these sections of the Far East about 85 per cent. of the world's rubber supply is received.



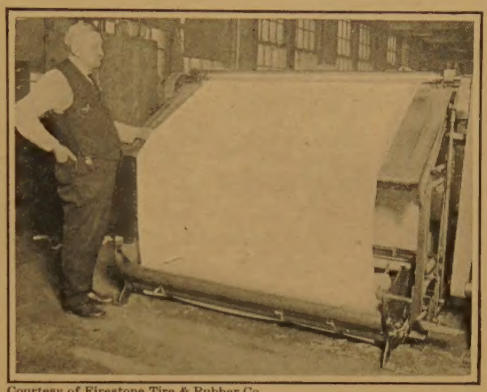
SHEETING RUBBER ON A HUGE CALENDERING MACHINE

What is Rubber?

We all know, or at least say we know, that rubber is obtained from the sap of a tree—that is, all of us except the man that actually gathers it, and he knows that it *does not* come from the sap at all but from the *latex* found in tubes that run lengthwise throughout the inner part of the bark. Sap is obtained by boring holes *through* the bark, but latex is obtained by cutting *across* the bark alone. Many people think that trees are cut down to get the rubber. This is only true to a slight extent, and holds good only in the case of certain vines which cannot be tapped. It was also true of a few trees felled by ignorant natives in the jungles of Africa. The appearance of latex is similar to that of milk; it is a thin, watery emulsion, made up of creamlike globules suspended in a thinner liquid of another composition. The creamy part of the latex is the basis of rubber.

The collection of latex varies but little whether it is in the jungles of Brazil or on

the plantations of Ceylon—but the treatment of the latex differs in both places. There are a number of methods used for collecting latex, the oldest of which is by making a V-shaped incision in the bark with a short-handled axe having a small blade. A small cup is placed under each incision and the thick milky fluid slowly issues forth into the cup. Another system in current use is the channel-tapping method in which a long cut is made down the tree, and then slanting channels are cut about one foot apart leading into the center vertical cut. The cup is placed at the bottom of the long cut to catch the latex. The flow continues for several hours when the latex begins to thicken. Finally it clots and the flow ceases. The latex is poured from the cups into earthen jugs or pails and taken to the rubber camp.



Courtesy of Firestone Tire & Rubber Co.

INSPECTING TIRE DUCK

The fabric passes over a glass table under which are strong lights that help to detect any flaws in the fabric

At the camp, the latex is coagulated by one of a number of methods in use. In the wilds of Brazil, the latex is slowly poured over a paddle which is held over smoke arising from a fire. The paddle is rotated and the rubber coagulates, the process being continued until a large "biscuit" is formed on the paddle. It is then taken off and is ready for shipment. On rubber plantations more exact systems are used for coagulation. The latex is there coagulated by either the direct action of acid or by the development of acid through the action of bacteria. The rubber solution, with the acid added is allowed to stand over night and in the morning the rubber is found floating on the top of the tank. The rubber, which is in a soft, spongy condition, is then kneaded, washed, rolled out into long strips, dried, cut and boxed ready for shipment.

Treatment of Crude Rubber for Manufacture

The first step in the process of manufacturing is the freeing of impurities from the crude rubber as it is received in the factory. Wild rubber, in the form of biscuits, is first soaked in hot water, and then passed again and again between corrugated rollers of huge washing machines that tear and break the rubber into small particles, streams of water passing over the mass at the same time. The water carries off the impurities exposed by the tearing action of the rolls. This mass of rubber is then passed between the rollers of another machine which press it into thin sheets which are hung up to dry, either by natural means or in rooms artificially heated. Plantation rubber, being clean, is not treated by this process, but is stored until ready to be used.

Courtesy of Firestone Tire & Rubber Co.

TIRE BUILDING ROOM

Photograph taken in one of the large Akron rubber factories

Compounding and Mixing

When the rubber, which has been thoroughly freed from moisture, is to be used, it is run between the smooth rolls of a warming mill. This machine consists essentially of two large smooth steel rolls rotating at slightly different speeds

towards each other so as to obtain a tearing action of the rubber stock. Suitable arrangement is made to pass steam and cold water into the hollow spaces inside the rolls so as to control their temperature.

The rubber is worked up on this mill until it is a soft, homogeneous mass ready for the addition of other ingredients. Aside from the sulphur, which is essential for vulcanization, other substances, known as "compounding ingredients," are added to the rubber batch to give the finished rubber product certain characteristics that cannot be secured in any other way. A few of the more common compounding ingredients and their purpose are here given: Zinc oxide, toughens the stock and increases its tensile strength; lampblack, toughens and gives black color; antimony sulphide, reddens the stocks and hastens vulcanization.

Courtesy of Firestone Tire & Rubber Co.

MOLDING CARRIAGE TIRES

The tire is being forced out through openings in the head of a tubing machine

The compounds are added slowly until they are entirely incorporated into the rubber mass. When the rubber mixture is entirely uniform in texture, it is cut off the rolls and sent to the compound stockroom, to be allowed to season for a certain length of time before being used. This is the form in which rubber is sent to the various departments of a factory to be made into the familiar rubber articles we see about us daily.

Spreading and Calendering

Fabric plays an important part in the construction of many rubber articles in common use. Take the rubber automobile or bicycle tire as an example. Without cotton fabric on which to build the tire we would not get the service that we are now receiving from our motor cars. Fabric to most rubber articles is what a steel framework is to the modern skyscraper. This is true of hose, rubber boots and shoes, rubber belting, waterproof fabrics and insulated wire, as well as tires. For this reason one of the most important operations in a rubber factory is the proper incorporation of rubber into the fabric to be used in a manufactured article.

The machine used for this purpose is the calender. It consists of three steam-heated rolls, one above the other, so geared together that the middle roll revolves in the opposite direction to the other two rolls. The rolls may be adjusted to form sheets of various thicknesses. Rubber is fed between the top and middle rolls, the rubber sheet adhering to the middle one while the top roll remains clean. A strip of cloth is passed between the middle and bottom rolls where it comes in contact with the rubber on the middle roll. The rubber is thus forced into the fabric or forms another sheet on the fabric, depending upon the size of the opening between the two lower rolls and the speed of the bottom roll. If a thin sheet of rubber is wanted, the bottom roll revolves at the same speed as the middle roll, but, if the rubber is to be forced into the fabric, then the space between the two lower rolls is decreased, and the bottom roll is revolved at about two-thirds the speed of the middle roll, causing a wiping action which forces the rubber into the meshes of the fabric. The rubber sheet may be cut into strips of any desired width by knives which press against the middle roll.

The sheet rubber and the impregnated fabric, called "friction," must go through a number of operations before being assembled into even a partly finished rubber product. They must be cut into strips or built into various thicknesses or several layers

CUTTING OLD TIRES FOR RECLAIMING PURPOSES

be fastened to each other in a number of different ways according to what article is being built. After being built, the rubber articles cannot be used until they are vulcanized, no more than bread can, properly, be eaten before it is baked.

Vulcanization can be grouped into two classes: heat, and non-heat processes. The former is the method now used in the larger majority of cases. The latter, or non-heat process, is a means by which rubber articles are vulcanized through the action of sulphur fumes, or a solution of sulphur chloride and carbon disulphide.

Vulcanization by the heat process method is carried on in a heater called a vulcanizer. This apparatus is of several types, for wet or dry heat. Articles such as tires are placed in molds in large vertical vulcanizers and steam and pressure is applied. A period varying from one to three hours is required to properly vulcanize by this method, depending upon the quality of the compound and size of tires. This is the wet heat process. The dry heat process consists in placing the article to be vulcanized, such as rubber soles and heels, between two steam heated plates to which pressure is applied. This process, due to the quality of articles vulcanized, takes but twenty minutes to one hour for completion. After vulcanization, the articles are removed from the molds, cleaned, trimmed, inspected and packed.

Rubber in Every-Day Use

Articles of rubber are used extensively throughout all industries today. Without them our home life would be changed, as would even the construction of modern buildings and ships. Let us, for a moment, consider their use in our homes. Garden hose contains a goodly proportion of rubber of inferior quality. Rubber matting for floors, stairs and porches finds extensive use.

Rubber insulated wire is used for lighting, cooking and heating in the home. A low grade of rubber, reclaimed from old rubber articles, is used in the manufacture of this wire on account of the low voltage used. In power houses, the insulation is of much better quality. Washers and gaskets for plumbing work are cut from large rubber sheets of the exact thickness required. Surgical goods, such as hot-water bags, syringes, gloves, tubing, are made of very good quality rubber so as to insure reliability in time of need. Rubber nipples and toys are manufactured, with due provision made to avoid poisonous minerals that might react with saliva. Rubber bands and erasers, jar rings, garters and suspenders, carriage and automobile tires, rubber overshoes, rubbers, waterproof coats and hats, rubber heels and composition soles, combs, brushes, rulers, are all articles in use in the average home, and show the part that rubber plays in our existence today. It has become a necessity largely on account of the desirable qualities peculiar to this material—the most important of which is elasticity. Crude rubber, when stretched, returns but slowly to a state of equilibrium, but when vulcanized, it returns to or near to its original state almost immediately. The increase in length after stretching is called the "set," and the aim of manufacturers is to reduce the set to as low a figure as possible.

Reclaimed and Artificial Rubber

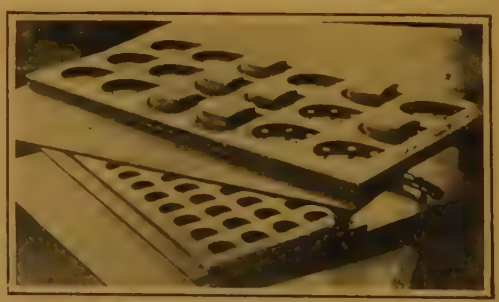
A MOLD FOR RUBBER BALLS
Showing the male and female sections of the molds, and, at the left, some finished balls

Used rubber articles usually find their way, as scrap, to the junk dealer, who in turn, sells them to large factories for reclaiming purposes. In this way much good rubber is obtained, and though not of best quality, good reclaimed rubber is better than the poorer grades of crude rubber, and, when used in conjunction with crude rubber, it finds many valuable uses. The first method of reclaiming consisted in grinding the scrap, and removing the fabric fibers and any particles of metal which were present,—after which the rubber was mixed with oil, heated, and then sheeted. Today, however, the cleaned rubber is heated in an alkali solution to remove all free or excess sulphur. After washing and drying, the rubber is heated on mills and sheeted. Reclaimed rubber finds much use in mats, garden hose, rubber shoes and packing, where waterproofing and wear-resisting qualities are desired rather than resiliency. Artificial rubber, known as "synthetic rubber," has never been a practical success, but it has been made in the laboratory in small amounts. In composition and in properties, it is almost equivalent to natural rubber, but the cost of such rubber is yet so high that none is manufactured, though Germany made synthetic rubber during the war because she could obtain no crude rubber supplies. Large factories in Germany were built to supply the need for rubber, but as soon as the war was over, manufacturers immediately started to import crude rubber, thereby virtually admitting that synthetic rubber is not likely to become a real competitor of crude rubber for a long time.

Position of the Rubber Industry

Looking back over the history of the development of the rubber industry we are impressed by the wonderful strides that have been made within a comparatively short span of years. It is only about eighty years ago that we learned how to use rubber—how to properly utilize it. However, the real development has come within the past several generations, for it was not until the advent of plantation rubber in 1876 that the industry really became a factor in our daily life.

A few figures showing the amazing growth in the volume of articles produced, and the supply of crude rubber, should be of more than passing interest. Twenty years ago the value of manufactured rubber goods in this country was $50,000,000. Ten years later, in 1910, the amount was five times as great. In five years the amount doubled and in 1917 it had increased to $800,000,000. Last year the figures had risen to over one billion dollars and this year we will produce over a billion and a quarter dollars' worth of rubber products —an increase of 2,400 per cent. in twenty years! Some statisticians even place the figures 25 per cent. higher than those quoted.



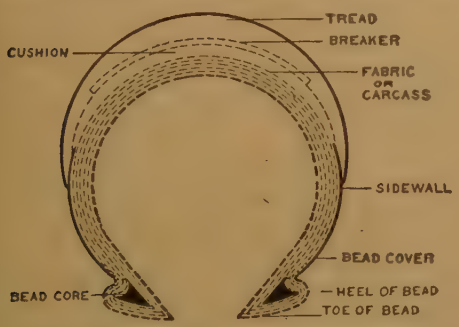
RUBBER HEEL MOLDS

Crude rubber production has likewise increased rapidly, for in 1905 the world's

production was but 62,000 tons. By 1915 it had more than doubled and in 1917 had risen to 257,000 tons. Today the world is producing over 350,000 tons, or about 700,000,000 pounds, of which the United States uses about 70 per cent.

The larger proportion of crude rubber goes into the manufacture of rubber tires for bicycles, carriages, motorcycles and motor cars of all descriptions. Last year there were registered in the United States over seven and one-half million cars, using in the neighborhood of 40,000,000 tires. This year's car production will bring the number of tires to be used to a total of 50,000,000. It is claimed that the number of cars this country can absorb is about 15,000,000, consuming about 75,000,000 tires—all of which will need to be replaced after they are worn out.

Various estimates place the number of articles made of rubber anywhere from thirty to fifty thousand. What additional articles will be made of rubber in the future can hardly be foretold with any degree of exactness, yet such an authority as Henry C. Pearson predicts the time when rubber will be used to make "rosewood, walnut, mahogany and ebony of the finest sort. Any rare wood can be simulated. It will not warp nor check, it does not absorb moisture. Its sawdust and chips mold again into the first shape. Even the boards, once out of use, can be ground up and used again and again." Another authority states that "in the light of past development it is not such a long stretch to the time when the rubber tire will meet a rubber pavement and the rubber sole will walk on a rubber sidewalk. This time, in fact, is nearer than we think. Experiments in rubber pavements have now been carried on for years and they have proven satisfactory from a practical standpoint. Cost is the only barrier at the present time—and the price of rubber is going down while the price of other materials is going up."



DRAWING OF FABRIC TIRE, CROSS SECTION

SUPPLEMENTARY READING

THE WHOLE ART OF RUBBER GROWING
By W. Wicherley

THE MANUFACTURE OF RUBBER GOODS
By Adolph Heil and W. Esch

RUBBER—ITS PRODUCTION, Etc.
By Dubosc and Luttringer

INDIA RUBBER AND ITS MANUFACTURE
By H. L. Terry

THE STORY OF THE TIRE
Issued free by Goodyear Tire & Rubber Co., Akron, Ohio

ARTICLES IN PERIODICALS

THE RUBBER INDUSTRY OF THE UNITED STATES . . . . . *By W. E. Brooke*
Yale Scientific Monthly, April 1911, v. 17: 303-308

ARTIFICIAL RUBBER . . . *By Ira Remson*
Scientific American, Sept. 16, 1911, V. 105: 245

A ROMANCE OF RUBBER . *By G. S. Patemoster*
Technical World Magazine, May, 1913. V. 19: 390-393, 466, 468

SKETCH OF CHARLES GOODYEAR
Popular Science Monthly, Sept. 1898

**Information concerning the above books may be had on application to the Editor of The Mentor.

THE OPEN LETTER

If all that we hear and read about Rubber comes true, we are headed for a Rubber Millenium. Among recent items of information a dispatch from London tells us that "a Rubber Age is predicted as a consequence of the discovery made by a Manchester chemist." Working alone in his laboratory one night, S. J. Peachey, lecturer at Manchester College of Technology, discovered that it is possible to vulcanize rubber speedily and perfectly by means of two cheap gases—sulphur dioxide and hydrogen sulphide—at a mere fraction of the cost of existing processes.

★ ★ ★

Astonishing claims are made as a result of this discovery. Rubber goods will be much cheaper, and, among other results, will be the production of boot soles lasting four times as long as leather ones, felt hats that will be very much cheaper than those now made, and a floor covering of rubber and sawdust at a price considerably under the present cost. Some rubber experts describe Peachey's discovery as "truly revolutionary."

★ ★ ★

Rubber has efficiently superseded, in whole or in part, many materials in common-day usage. That we have not seen the last of this substitution is shown in the statement of a leading authority that the day will soon come when we will be using rubber furniture—desks, chairs, tables, etc. Rubber, shaped into the forms of furniture can, even today, be made to imitate closely oak, mahogany, walnut, and other woods. Confident claims are made that this phase of the rubber industry will be an important development of the future. Imagine a piece of rubber furniture, which, after being broken, can be sold as old rubber—the rubber being reclaimed, so that it may be used over and over again. Rubber, molded in slabs or blocks, can be sawed or turned in a lathe, just as a piece of wood can be. The future holds surprises for us all, for not only will we have rubber flooring, pavements, and heels, but we will sit on rubber chairs, and eat off rubber tables, and work at rubber desks—furniture that can hardly be distinguished from wood. We ride now in "Rubber-neck Wagons." The time is near when we will find the wagons themselves made, for the most part, of rubber.

THE DAY OF RUBBER

For centuries a tropic plant,
Obscure and insignificant,
Common to both worlds, West and East,
I did no good to man or beast.
Yet now my rich and viscous juice,
Turned to a locomotive use,
Has lent the rigid chariot wheel
The limber movements of the eel.
And oils that kindle and explode
Have made me Monarch of the Road.

—(*Punch*, London)

★ ★ ★

It is interesting to speculate on the prospects of so lively and promising an industry. Perhaps, however, some of the speculations are merely fanciful. Perhaps some of our rubber optimists have elastic imaginations, and, so, are inclined to stretch facts. As the French say, "we shall see what we shall see."

★ ★ ★

A few years more will tell the story. Charles Goodyear was born in 1800, and began his experiments in 1834. Already, in our day, rubber is declared to be the *fifth necessity of life*. Give the industry fourteen years more, and we will have a hundred years of it. If, then, a rubber millenium is realized, we shall witness an achievement unique in human progress—a millenium reached in a hundred years.

W. D. Moffat

EDITOR

E PAINTING BY J. P. A. HEALY

CHARLES GOODYEAR (1800-1860)—PIONEER OF THE RUBBER INDUSTRY

THE STORY OF RUBBER

Charles Goodyear—the Discoverer of Vulcanization

ONE

FEW people realize the real importance of the remarkable discovery of vulcanization by Charles Goodyear in 1844. A true inventor, scorning great financial returns—such was the type of man who failed to live long enough to see even a small portion of the vast development following his discovery. Fame came to him late, for only at the present time, attempts are being made to include the name of Charles Goodyear in the Hall of Fame at New York University—and whether or not his name is inscribed there at this time, the day is undoubtedly not very far distant when it will be perpetuated amidst those classic columns.

Charles Goodyear was born in New Haven, Connecticut, on December 29, 1800. His education was limited to the public school grades, and, upon reaching his majority, he started in his father's hardware and agricultural implement factory in Philadelphia. Reverses overtook the plant in 1834, and this stroke of ill-fortune was the means of giving Goodyear the opportunity he desired to experiment with the rubber gum which was, at that time, being used to a limited extent. In 1836 he had devised and patented a process of treating the surface of rubber goods by dipping them in a preparation of nitric acid. He started in business in a small way, and soon failed, yet his process was successfully used by others in the manufacture of rubber shoes.

Convinced that rubber was one of the most useful substances in the world, Goodyear continued the task of finding a way of making it more serviceable. After years of effort he had learned that sulphur was valuable in its treatment but had only half solved the problem. During all his experiments he had not thought of applying heat, because even a slight degree of heat turned the substance into a sticky, shapeless mass. Then by accident, in 1844, he found that a high degree of heat was the very thing needed. Even then it took him five years more to so work out his process so that it was entirely satisfactory.

He was a quiet, sickly, thoughtful man. During the periods of his experiments he and his family were often in dire want, and only the kindness of friends kept them from starvation. However, Goodyear refused to be swerved from his objective and wrestled with his problem until he had accomplished his aim. He had now succeeded in so treating rubber that articles made of it no longer were affected by temperature changes. Formerly, rubber articles became stiff and brittle in cold weather and soft and sticky in warm weather. Now, having discovered the proper method of treatment, instead of resting on his laurels, he set to work to put his discovery to practical use. In speaking of this phase of his work, his son, William H. Goodyear, Curator of Fine Arts at the Brooklyn Museum, said a short time ago:

"It is a matter of record that, with rare exceptions, all the intensive applications of rubber (and there are over two hundred of them) were devised, launched and financed by Charles Goodyear up to the point where any other business man or manufacturer could do the rest, and at that point he invariably began to develop a new application. He never was a manufacturer in the strict sense, or beyond the early days when manufacture was the only means of earning money for experiments. It lay within his power, at any time after 1844, to identify himself with some one of the great industries which he successfully launched, and to share by this activity more largely in the enormous profits which these industries produced under protection of the patent laws. His greatest glory is not that he discovered vulcanization, but that, having discovered it, he scorned the wealth which the discovery created, except insofar as it helped him in the nobler task of continuing to create new industries."

In placing rubber at the service of mankind, Goodyear made available a substance of so many characteristics that its uses are almost countless. Rubber is used for certain purposes because it stretches, for others because it is airtight and watertight, or because of its plasticity, hardness, adhesiveness or non-conducting property. Goodyear received a number of medals at foreign expositions in appreciation of his work. Chief among them were those given him at the London exposition in 1851 and in Paris in 1855. He died in poverty in New York on July 1, 1860.

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T. UNDERWOOD & UNDERWOOD

GREAT SNAKY-ROOTED RUBBER TREE NEAR KANDY, CEYLON

NATURE, with its complexity of problems, always has found a means of shielding from harm not only human beings but all plant forms as well. Cut your finger and the blood which exudes soon clots or thickens to prevent a further flow. In much the same way, when the bark of a rubber tree is penetrated, a thick viscuous juice pours forth to heal the cut. If this juice is caught while still soft it can be treated to obtain rubber.

Let us for a moment consider what a rubber tree looks like. Does it grow high? Is it a thin or thick trunk tree? What do the leaves look like? We naturally like to compare in our minds the difference between the rubber tree grown in the tropics and the average tree met with in this country, such as the elm or oak. The best rubber-producing tree is the *Hevea*—a tree which often grows to a height of sixty feet and when full grown is eight or ten feet around. It rises straight as an elm with the branches and leaves well up from the ground. The leaves are long and smooth, and have three lobes. In the late summer—in August or September—sprays of pale flowers blossom forth, and a few months later, the pods, which are about the size of our hickory nut, ripen and burst, shooting the small seeds in all directions. On plantations these seeds are collected and planted in nursery beds.

Full of danger and adventure is the life of a rubber gatherer, or *seringueiro*, in the wilds of Brazil. The workers start up the Amazon river in March or April, the journey taking five or six weeks. When the rubber region is reached, a number of workers are dropped off at each *seringal*, a small village used as the center of operations for a certain territory. Some *seringueiros* choose to work close to the *seringal*, while others chop out paths into the interior, where they build a thatched hut for a home.

Early in the morning, the gatherer starts on his daily round, for the latex flows best early in the day. He has with him his tapping knife and a number of small tin cups. As he comes to a rubber tree he carefully cuts through the bark to the cells containing the latex, using care not to cut the woody inner fiber of the tree. At the bottom of the gash he has made, the gatherer inserts his tin cup, into which the latex flows. Trees differ greatly in the amount of rubber milk they give up, and soon the gatherer learns the productivity of each tree on his route. He goes from tree to tree until he again reaches his starting place. Now he starts on his round the second time, carrying a pail to collect the latex which has accumulated in the cups. These operations take but a small part of the morning, and he usually returns to his hut several hours before noon for a late breakfast.

The hardest part of the work is still before the *seringueiro*, for he must harden the morning's collection before it spoils. So he builds a fire of wood and nuts, and places a crude funnel over the fire so that the smoke comes out at the small end. A stick dipped in the rubber milk is then held over the black smoke until the rubber coating has become a yellowish color, when it is dry. This operation is repeated, until, layer by layer, a huge biscuit or *pelle* is built up.

At the end of the week, the gatherer loads his biscuits on his back or into boats and takes them to headquarters, where the *pelles* are weighed. The rubber is sold by a middleman, who deducts about a quarter of the amount received as a commission. After stocking up for the week, the rubber gatherer again starts on his journey up-river, to go through the same routine for another week.

Such is the method used in the collection of wild rubber. Plantation rubber, on the other hand, does not offer the same difficulties, for, usually, white men living in comfortable bungalows with their families are used as gatherers. Tapping and gathering on a rubber plantation is much the same as in the wilds of Brazil and Africa, without the many discomforts. However, the method of drying or hardening varies considerably, for on plantations special plants are erected where the latex is treated with acids to cause coagulation. The rubber, in the form of lumps, is then put through a rubber mill and rolled out into thin sheets, after which it is dried and smoked by being hung over poles in the smoke house, a process somewhat similar to that used in the smoking of hams. After being wiped free of soot, the sheets are folded, sorted and packed in wooden boxes, and loaded on small lighters which carry them to waiting ocean steamers.

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THE STORY OF RUBBER

Manufacture of Rubber Clothing

THREE

RUBBERIZED coats are of two distinct classes,—the common rubber surface coat as seen on postmen, firemen and teamsters, and the mackintosh or slip-on coat with a cloth surface, such as is used for every-day street wear. The rubber coat is made from a fabric with a coating of rubber, while the mackintosh is made with a rubber lining sometimes backed up by another lining of fabric. The latter is known as a double-texture coat.

The process of manufacture, whether for a calendered rubber coat or mackintosh is practically the same. The various steps consist of coating the cloth, cutting the coats, making, vulcanizing, finishing and examining. Before being coated with rubber the cloth is examined and thoroughly dried.

In the calendered or rubber surface coat the coating of rubber on the material is applied through the medium of a calender, whose operation has previously been explained. For mackintoshes, of either the single or double texture type, a spreading machine is used to coat the fabric with the rubber compound. In this case the rubber is placed against the edge of a horizontal adjustable knife and the fabric is passed under the edge of the knife. As the fabric moves it is coated or impregnated with the rubber. For double-texture coats, the lining is treated in the same way, and then the coated surface cloth and coated lining are pressed together by heavy rolls so as to make one piece of material having the rubber coating between the two layers of cloth. In the single-texture fabrics, the rubber lining or coating may be colored or striped with different colored rubber solutions so as to give the effect of a lining of cloth.

In cutting either a rubber surface coat or a double or single-texture slip-on, the operation may be done by hand with a knife, or by an electric cutting machine. The fabrics are laid up in thicknesses varying from forty to seventy-five layers of cloth, the quantity of layers depending on the weight and texture of material to be cut. The pattern is marked by means of a perforated sheet of paper on the top layer of fabric. This perforated sheet is spread out by the cutter, who dusts over it with a chalk bag, the chalk sifting through the perforations to the cloth beneath, leaving the outline of the parts to be cut and the lines that the knife is to follow. Generally speaking, the rubber coats are cut by hand, while the double and single-texture fabrics are cut with an electric machine.

After cutting, the work is put up in bundles, each bundle consisting of every piece necessary for a given garment, and the work is then passed to the makers. Generally, the first operation is putting together the sleeves, collars, backs and fronts, and then the several parts are joined together into a completed coat. In the calendered or rubber surface coat the seams are all cemented, although, in some instances, stitching may be employed at certain points to add strength.

In the double and single texture slip-on coat, the seams and various parts are stitched together by either single or double-needle machines, and all seams covered with a strip of cloth known as strapping, this strapping being applied by means of a coating of special cement. The coats are then ready to be vulcanized.

The very important operation of vulcanizing is performed by subjecting the garments to a heat of varying temperature for a duration of several hours in a huge oven, so that the garment may be able to withstand extremes of temperature.

The process of finishing includes the putting on of the various types of fasteners, whether buttons, buckles, ball and sockets, or otherwise. In rubber surface coats, metallic fasteners of different kinds are ordinarily used, and are riveted to the coat by automatic machines. In double and single-texture coats, buttons and buttonholes are employed. Rivets are also used, to give added strength to certain parts of the garment.

After finishing, the garments are thoroughly examined for defects in workmanship or material, and when this operation is completed, they are folded and properly tagged and are ready to be applied on the various orders.

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UNDERWOOD

MAKING RUBBER FOOTWEAR—INSPECTING RUBBER BOOTS IN AN AKRON (OHIO) FACTORY

THE STORY OF RUBBER

Manufacture of Rubber Footwear

FOUR

JUST as rubber tires have supplanted tires of wood and iron, so rubber shoes have supplanted those made of leather, for many purposes. With refinements in manufacturing, rubber shoes are produced today which compare very favorably with leather shoes, both in looks and wearing qualities. Whereas years ago cheap materials, hastily thrown together, were used, nowadays, only the best materials go to make up rubber footwear under almost ideal conditions. Various colors are now used for soles and heels, allowing of a choice of rubber footwear for many occasions. One rubber company even went so far as to advocate its high-class rubber shoe for evening wear to displace the customary patent-leather shoe, during the times of leather shortage and consequent high prices.

A number of types of rubber footwear are made; chief among are tennis shoes, arctics and boots. Rubber shoes are, for the most part, made by hand, the several parts being put together with cement instead of stitching, as is the case in leather shoe making. The principal operations are as follows: lasting, cementing, uppering, sole cutting, outsoling, edging, varnishing, finishing and curing.

Before any of the assemblying takes place, fabric for the tops or uppers must be cut. This is accomplished by means of cutting dies of suitable shape for the various cloth parts. The fabric is arranged in slabs about an inch thick and metal dies cut out with great rapidity and exactness pieces of the required size and form. The first operation is known as lasting. Taking a last the operator first covers it with the shoe lining. After this has been stretched smoothly over the last and the edges folded over the bottom, the inner sole is put in place. The lasted shoe is then given a coating of rubber cement which is allowed to dry before the application of the rubber parts. The heel and toe pieces are then cemented on, the different parts being rolled out smoothly and the seams pressed down tightly with a rubber roller.

The vamp, the part which forms the instep, is put into place, and the edges of the top of the sole are folded over to form the heel seam. The rubber stock for outer soles is run in sheet form by a special calender provided with a gnarled or grooved roll to impress the design for the sole and heel surface. This sheet is then cut by machinery into the proper size and shape. The soles are then cemented and placed on the shoes. This operation is called outsoling, done partly by hand and partly by machinery. A power edging machine welds the sole down firmly by the action of a hammer driven at a high speed. Before the shoes are vulcanized, they are varnished with a preparation which gives them the appearance of patent leather and renders them capable of withstanding great changes of temperature without cracking. Shoes with cloth tops are varnished by hand while whole rubber shoes are dipped in the varnish.

After the shoes are varnished they are cured in pressure vulcanizers. Each "heat" contains six to eight cars of eighty to two hundred pairs of shoes each. The temperature is increased gradually until it reaches about 260° F. After the vulcanization the shoes are stripped off the lasts, trimmed, inspected, tied, sorted and boxed.

Shoes with one buckle are called arctics, while those with two or more buckles are called gaiters. Gaiters range from the low two-buckle to the high six-buckle shoes, while some are with buttons or laces instead of buckles. Lumberman's are a heavy shoe about midway between gaiters and rubber boots. Some are made with cloth tops and others with rubber tops, fleece-lined. Canvas shoes, ranging from the rubber hospital slipper and the pump to the men's work shoe and the women's fancy high top shoe with twelve or more eyelets are classed under the general name of tennis shoes. All of these types, including boots, are made in much the same fashion as the rubber shoes already described, with minor changes due to the difference in the various types.

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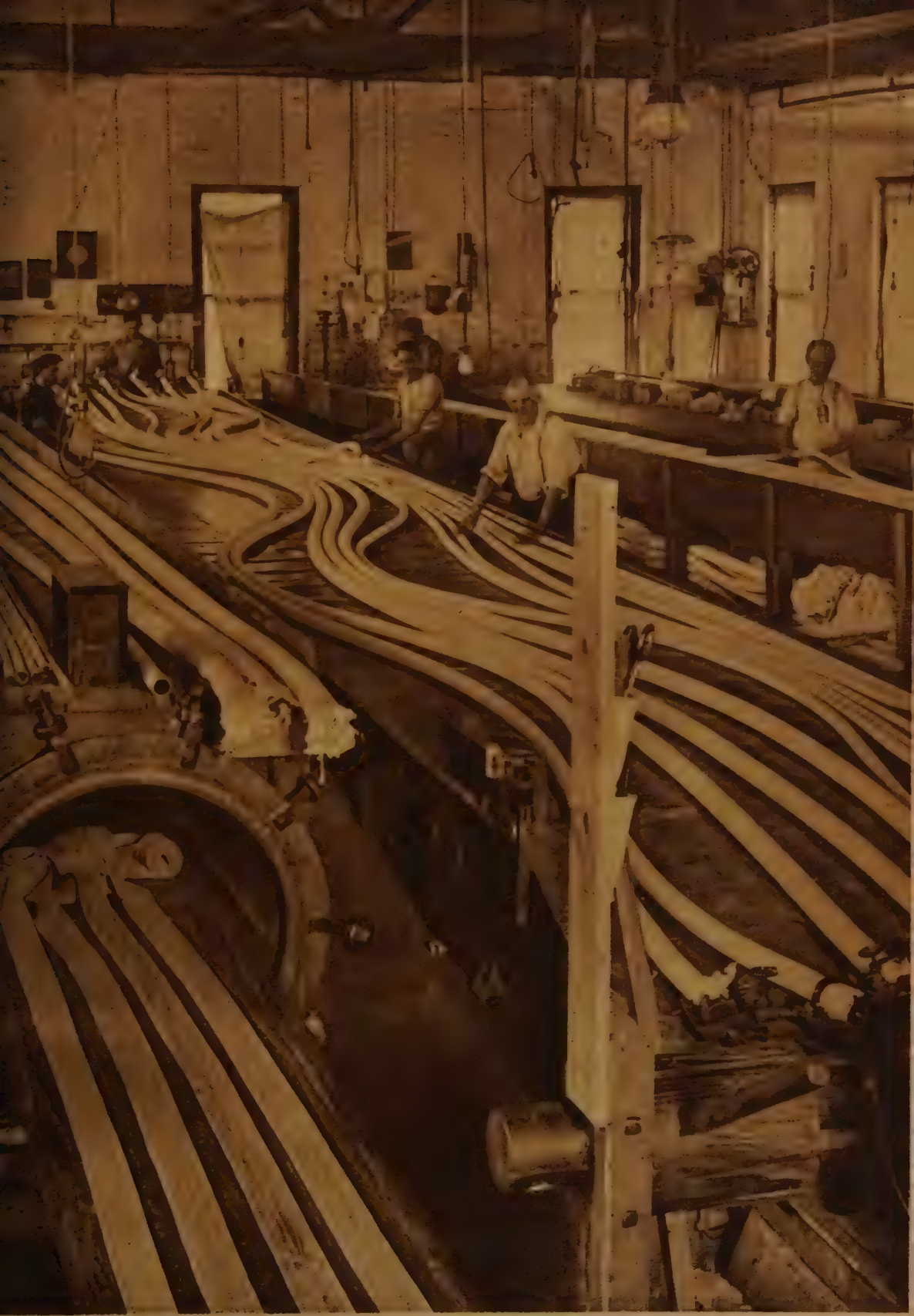

RUBBER HOSE MANUFACTURE—VULCANIZING ROOM IN HOSE DEPARTMENT OF RUBBER FACTORY

PROBABLY the more common varieties of rubber hose are those in general use in the household, such as garden and gas hose, but these, by no means, comprise the larger portion of the output of a hose factory. Rubber hose can be divided into two main divisions, small and large. Small hose, usually called "plied" hose, is used for low pressure work and can be hand made, braided or molded. The larger hose, usually made entirely by hand, must be able to withstand high pressure,—fire, air-brake, vacuum and suction hose being samples of this type.

A description of the method of manufacture of the small hand-made hose will serve as an illustration of the various steps necessary in making hose. Fundamentally the manufacture is divided into making the rubber tube used as lining and the building of the fabric body with its rubber outer casing.

The inner surface of small hose is generally rubber made in the form of a tube on the tubing machine, an apparatus similar to the familiar meat grinder. Dies of tubing machines can be adjusted so as to produce a wall of any desired thickness. As the rubber tube is forced through the tubing machine, it is wound in a tray and dusted with soapstone, and, later, cut into lengths of about fifty feet. These lengths are then put on mandrels, long steel tubes, by means of compressed air. One end of the tube having been placed over the end of the mandrel, air pressure is applied at the other end to expand the tube, making it easy to draw the rubber tubing over the mandrel.

After the tubing has been blown on the mandrel, it is ready for its canvas cover. Small hose is usually wrapped by machinery consisting of three rolls about two inches in diameter and the same length as the rubber tube. The mandrel carrying the rubber tube is placed on the two lower rolls, which are beside each other, while the third roll can be lowered onto the mandrel. A rotary motion of the rolls causes the tube to revolve, and the canvas and rubber cover are wrapped on in a few seconds. Larger and better quality hose is made up by hand, with the aid of small hand rollers, which are run up and down the hose, thus serving to press each ply of canvas on to the next. After being covered, the hose is wrapped in cloth, and ready to be vulcanized.

Braided hose, in which the duck middle is braided on the rubber tube instead of being wrapped on, is made by partially curing the rubber tube, and then passing it up through the center of a loom where the braid is put on by a system of spools of cotton thread which follow a crossing, zigzag course around a circular table. While being vulcanized, hose of this kind is subjected to air pressure from within to force the rubber well into the meshes of the loosely braided fabric.

The vulcanizer consists of a long, cylindrical chamber six or eight feet in diameter, provided with steam and drip connections and a pressure gauge. The pressure and time necessary for vulcanization depend upon the composition of the rubber compound, the thickness and the use for which the hose is intended. After the hose has been cured the fabric wrapping is stripped off and the hose is removed from the mandrel by means of compressed air in much the same way that the tube was put on. The ends are then trimmed, couplings are put on and the hose is ready for shipment.

Where it is desirable to obtain unusual lengths of hose without joints it is necessary to braid the duck middle around the tube. The various plies of duck are put on separately, each ply having thin coating of rubber between it and the next. These thin coatings are put on by running the hose through the tubing machine, the outer cover being put on in the same way. Curing is effected in large presses which are grooved to the same diameter as that of the hose. In some of these presses the grooves are spiral in form.

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THE growth of the rubber industry has depended to a large extent upon the continued wide spread usage of automobiles and their rubber tires. Today, almost three-quarters of the total rubber produced is used in the manufacture of tires, tubes and accessories for motor cars—showing the dependency of one great industry on the other. Looking back over the history of the development of the tire as we know it today, one is immediately impressed by the mass of litigation which followed each new step. Inventive minds seemed to be working in the same channels both abroad and in this country and many of the earlier types of tires were developed almost simultaneously by different concerns. One of the first records of a patent which was the forerunner of our present tire, was that given to Thomson in England in 1845 for a hollow elastic belt consisting of several thicknesses of canvas saturated with rubber. This tire, however, came into little use and was soon forgotten.

Later, in 1884, solid rubber tires were made in the same country and used on bicycles. The success of this type soon caused a revival of the pneumatic tire, and in 1888 Dr. J. B. Dunlop patented and started to manufacture a tire upon which our modern tire is based.

With improvements in the methods of manufacture and methods of attachment to the rim, great development took place. Today pneumatic tires differ but little in outward appearance, and in construction they will be found to be very similar, for standardization has entered so much into their manufacture that tires of different makes are nearly all alike, even the manufacturing processes being very similar.

Pneumatic tires are divided fundamentally into two classes, that in which cotton fabric, similar to a cotton duck material, is used as a foundation and that in which cotton cords heavily impregnated and covered by rubber are used in place of the fabric. The first type is known as the fabric tire and the latter as the cord tire. A brief description of the methods of manufacture of both these types is here given.

How fabric is impregnated with rubber and rubber is rolled out into thin sheets on the calendering machine has already been told. From the calender room, the stock, both "friction" and sheeted rubber, in the form of huge rolls is taken to the stock preparation department. The rubber coated fabric is first cut into strips of proper width so that they will extend from bead to bead over the top of the tire. These strips are cut on a bias, at a 45-degree angle with the edge of the strip, after which they are spliced end to end to make up a large roll.

Pneumatic tires are built up on solid iron cores which conform to the inside shape of a finished tire. These cores are mounted on machines which apply the strip fabric which was put up in rolls, around the circumference of the core at a uniform tension. This machine method has almost entirely superseded the application of the fabric by hand. After a few layers of fabric have been placed on the core, the bead is inserted in its proper place. Then several more layers of fabric are added, at the same time disks and rollers take all unevenness out of the fabric as the core revolves. This is called the body or the "carcass" of the tire.

The carcass, still on the mold, is now dismounted and taken to the finishing room where the side walls, cushion, breaker strip and tread are applied by hand. The tire is now complete and resembles the tire as we generally see it on cars. Yet it is soft and uncured and must be vulcanized before being fit for service. The tire is put in a steel mold, about twenty of these molds being placed on top of each other in a huge vertical vulcanizer. The top of the vulcanizer is closed and the molds are forced tightly together by hydraulic pressure to assure an even flow of the gum and to prevent steam from entering the mold during the process of curing. The length of cure varies from one to three hours according to the size of tire being vulcanized. From the vulcanizing pit, the tires are taken to another room where they are cleaned and inspected, after which they are wrapped in paper and ready to be shipped.

Cord tires are gradually replacing fabric tires, and it is predicted by many that the cord tire will be the ultimate type of pneumatic tire. The more common construction for cord tires is the multiple-ply type of six, eight or more plies of cords varying according to the size of the tire. The manufacturing operations for the cord tire are very similar to those used for the fabric tire. The cords are made into a cord layer held together by very light threads spaced about one-half inch apart. These threads serve only to hold the cords together until they are cemented and given a coating of rubber. These rubber coated cords are then handled similar to the impregnated fabric used in the fabric tire, to make up the cord tire. The cords are side by side, all running in one direction. After being built up the cord tire is vulcanized in much the same way as the fabric tire, the main difference being that cord tires are stripped off the cores after being built and air-bag molds are inserted so that they are vulcanized by an internal as well as external pressure process.

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RUBBER—A Wonder Story

By JOHN MARTIN, Editor of *John Martin's Book*

FROM the markets to the homes, and offices, and garages of the nation the adventures of rubber are too varied to be told in this story. Goodyear's discovery was merely the beginning of making rubber practical. He, himself, experimented with it all his lifetime. During many years rubber was manufactured by guess, much as the Southern mammy does her cooking. Now every rubber manufacturer has a great staff of scientific cooks, or chemists, who spend all their time hunting for new combinations.

Mother probably has her special blend ot coffee that she prefers above all others. Father may insist upon a particular mixture of tobacco; so the rubber chemist must find a definite combination for every kind of use to which rubber is put. The reason some companies have better goods than others is that their chemists have been able to discover better recipes. These recipes are the guarded treasures of the rubber men, for their manufacturing secrets are their real capital and are worth thousands and even millions of dollars.

Scientists are trying to make "synthetic" or artificial rubber, which is, to combine in the laboratory the elements that make rubber, and so rival the methods of the great out of doors where Mother Nature uses the sun, the moisture, and the good, rich earth to bring forth a white, gummy tree juice. But this chemical rubber is very costly, and for a long time, at least, nature's product will be cheaper and better.

How important rubber has become we may gather from the laws Germany passed during the war, punishing any one who threw away an article made of rubber. Of all the privations which that besieged country was suffering, rubber was one of its most serious needs, so when the first merchant submarine, ***Deutschland,*** returned from its famous trip to this country, it was rubber that largely made up the cargo.

It is only eighty-five years since we have known how to use rubber, yet it would set us back more than a century in the comfort and business of living if it should suddenly cease to be. As the use of animal skins for shoes paved the world with leather, so the invention of pneumatic tires and rubber soles and heels has cushioned the world with rubber.

You could not go through a single day without the service that rubber gives you. To be deprived of rubber bands, balls, buttons, buckles, of combs, supporters, elastics, bandages, raincoats, erasers, of fountain pens, typewriters, motor trucks and motor cars, fire hose and factory belts, to mention just a few of the things rubber makes possible, would leave you wildly hunting for substitutes in order to go on with your day's work or pleasure.

Yet, the rubber industry is still in its infancy, and we have told you only the beginnings of what it will some day mean to us. Who knows which one of you, boys and girls now, will realize dreams of discovery and manufacture that to-day seem only fantastic fairy tales of imagination? For the romance of rubber is only begun, and its wonder story of the future would thrill us all could we but hear it told.

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